C008: AVALANCHE HAZARDS

TSP Number/Title	C008: Avalanche Hazards
Effective Date	Implement next class iteration upon receipt
Supersedes TSP(s)/Lessons	None
TSP User	The following courses use this TSP: Cold Weather Instructor Qualification Course (CWIQC) Command and Staff Orientation Course (CSOC) Cold Weather Leaders Course (CWLC)
Proponent	United States Army Alaska, Northern Warfare Training Center
Improvement Comments	Send comments and recommendations on DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to: ATTN: TRAINING ADMINISTRATOR COMMANDANT USARAK NWTC 1060 GAFFNEY ROAD #9900 FORT WAINWRIGHT AK 99703-9900
Security Clearance/Access	Public domain
Foreign Disclosure Restrictions	The Lesson Developer in coordination with the USARAK NWTC foreign disclosure authority has reviewed this lesson. This lesson is releasable to foreign military students from all requesting foreign countries with Approval of Commandant USARAK NWTC.

PREFACE

Purpose This training support package provides the instructor with a standardized lesson plan for presenting instruction for:

Task Number	Task Title
VI.0100	Avalanche Hazards

Technique of Delivery

Lesson Number	Instructional Strategy	Media
C008	Avalanche Hazards	PowerPoint

This TSP contains

	Table of Contents	**Page**

C008: AVALANCHE HAZARDS

SECTION I **ADMINISTRATIVE DATA**

All courses including this lesson

Course Number(s)	Course Title (s)
	Cold Weather Instructor Qualification Course (CWIQC)
	Command and Staff Orientation Course (CSOC)
	Cold Weather Leader Course (CWLC)

Task(s) Taught or Supported

Task Number	Task Title
VI.0100	Avalanche Hazards

Task(s) Reinforced N/A

Test Lesson Number

Hours	Lesson Number	Lesson Title
1	C020	CWLC Review

Prerequisite Lesson(s) **None**

References

Number	Title	Date	Additional Information
	NWTC Cold Weather Operations Manual	FY04	Updated yearly
	NWTC Mountain Operations Manual	FY04	Updated yearly
FM 31-70	Basic Cold Weather Manual	1968	http://www.adtdl.army.mil/
FM 31-71	Northern Operations	1971	http://www.adtdl.army.mil/
FM 3-97.6	Mountain Operations	November 2000	http://www.adtdl.army.mil/
	Snow Sense		Jill Fredston and Doug Fessler

Student Study Assignment	Students should read C008
Instructor Requirements	CWIQC graduate, TAITC graduate
Additional Support Personnel Requirements	One assistant to operate proxima
Equipment Required	Computer and proxima
Materials Required	Instructor Materials: • NWTC Cold Weather Operations Manual • Snow Sense • Avalanche Video Student Materials: • NWTC Cold Weather Operations Manual
Classroom, Training Area and Range Requirements	Classroom to accommodate 75 students
Ammunition Requirements	None
Instructional Guidance	Before presenting this lesson, instructors must thoroughly prepare by studying this lesson and identified reference material.

Branch Safety Manager Approval

NAME	Rank	Position	Date
Mark Gilbertson	GS-09	Training Specialist	

Proponent Lesson Plan Approvals

NAME	Rank	Position	Date
Peter Smith	GS-12	Training Administrator	

SECTION II **INTRODUCTION**

Method of Instruction: Lecture
Instructor to student ratio: 1:75
Time of instruction: 1 hour
Media: Proxima

Motivator

(Slide 1) Avalanches surprise more people in the winter than any other hazard. Many of these surprises end in casualties. In addition to casualties, the military significance of an avalanche can be blocked mobility corridors that require the commitment of resources to clear and/or the loss of equipment. Tactically, artillery has been used to trigger avalanches to bury enemy forces or block routes. This occurred most notably in WW I, where over 60,000 soldiers were lost to avalanches.

Terminal Learning Objective

At the completion of this lesson you (student) will:

ACTION:	Identify and evaluate the risk of an avalanche take steps to mitigate this risk
CONDITION:	In a classroom environment
STANDARD:	Identify and evaluate the risk of an avalanche take steps to mitigate this risk IAW the NWTC Cold Weather Operations Manual.

Safety Requirements

None

Risk Assessment Level

Low

Environmental Considerations

Low

Evaluation

Students will be evaluated on the comprehension of lesson material by a written test.

Instructional Lead-in

(Slide 2) Avalanches have had a significant effect on military operations in snow covered terrain. The Salang pass in Afghanistan is a main link between Kabul and northern provinces. In winter it is the only link with the north as other routes are closed by heavy snows. Located at an altitude of over 11,000 feet, the Salang pass has been closed in winter as the result of avalanches, creating significant logistical difficulties for ongoing military operations.

Avalanche Hazards in Mountainous Terrain

- ***Types of Avalanches***
- ***Recognizing the Hazard***
- ***Avalanche Triggers***
- ***General Indicators of Avalanche Prone Terrain***
- ***Route Selection and Hazard Evaluation***
- ***Traveling in Avalanche Prone Areas***

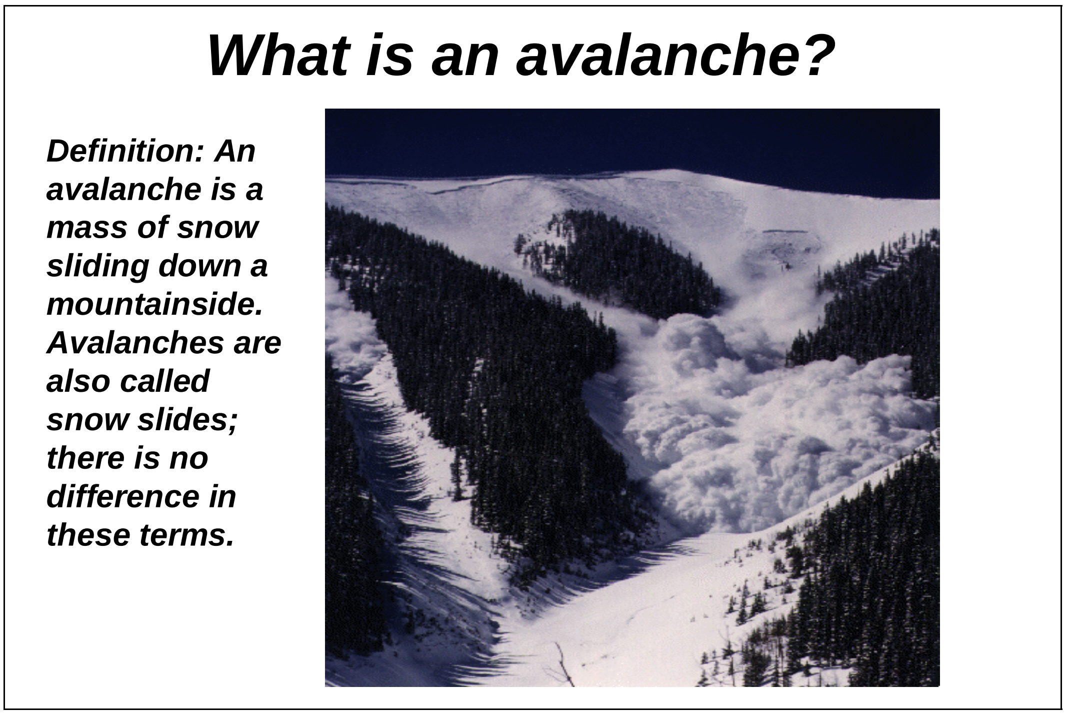
SECTION III	PRESENTATION

ELO A

ACTION	Define avalanches, identify the types of avalanches and describe the effects of avalanches
CONDITION	In a classroom environment
STANDARD	Define avalanches, identify the types of avalanches and describe the effects of avalanches IAW the NWTC Cold Weather Operations Manual.

Learning step/ Activity 1- What is an avalanche?

a. (Slide 3) An avalanche is a mass of snow sliding down a mountainside. Avalanches are also called snow slides.



Learning Step/Activity 2 – Type of Avalanches

a. (Slide 4) There are two main types of avalanches – loose snow or point release avalanches or slab avalanches.

Types of Avalanches

1. Loose snow avalanche or point release avalanche

2. Slab avalanche

b. (Slide 5) The loose snow slide or point release usually occurs on steeper slopes from 35° and up. Loose snow slides start small, at a point, and grow in width as descent occurs, picking up more snow as it goes; typically this involves only the very top layer of fresh snowfall. These types of avalanches typically do not carry much snow but can trigger slab avalanches. In late spring, however, these types of slides can carry become very significant as they become wet snow slides carrying large amounts of heavy wet snow that can be quite destructive. They can also be the trigger for a large slab to break.

Point Release Avalanche

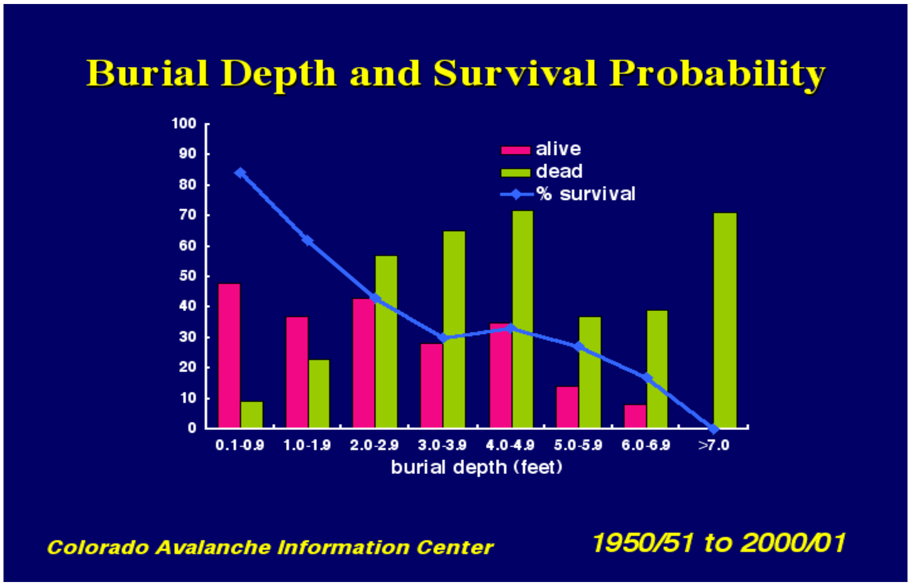
ALTHOUGH USUALLY SMALL,THEY CAN TRIGGER A SLAB TO RELEASE

c. (Slide 6) Slab avalanches contain a more cohesive mass of snow. The formation of a slab can occur at any depth in the snow pack. A typical winter snow pack could contain many separate slabs varying from an inch to ten feet or more in thickness. Each new snowfall eventually forms a definable layer in the snow pack. The bonding of these adjacent layers determines the overall strength of the snow pack. Not all layers in a snow pack evolve into slabs. Many detailed events occur within the history of the snow pack to affect the bonding process. The lack of a strong bond between layers increases the probability of avalanche. In addition to the strength of the various layers, other factors affect avalanche probability.

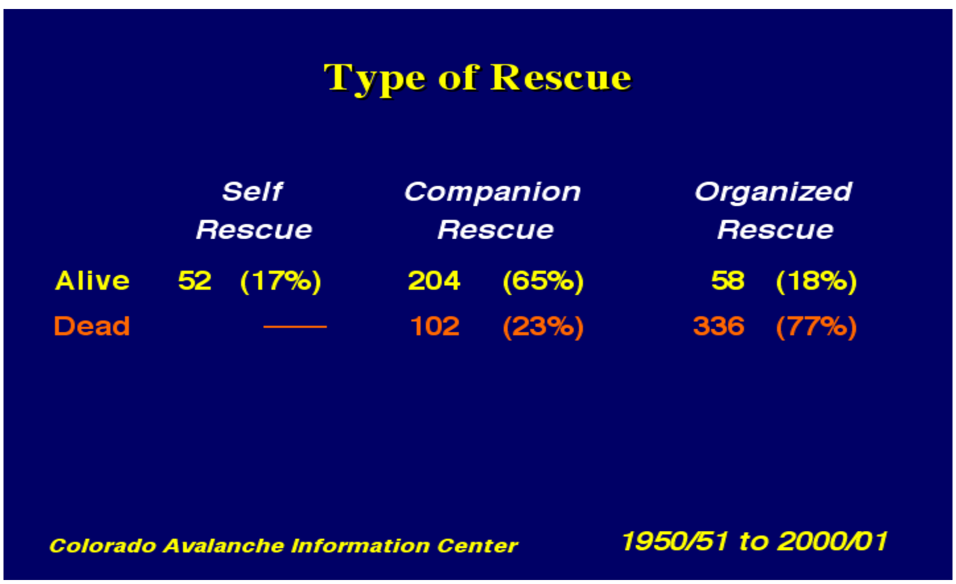
d. The crown is the "starting zone". This is where the fracture occurred. The track is the path the slide took. The run out is where the slide stopped.

Learning Step/Activity 3 – Effects of Avalanches

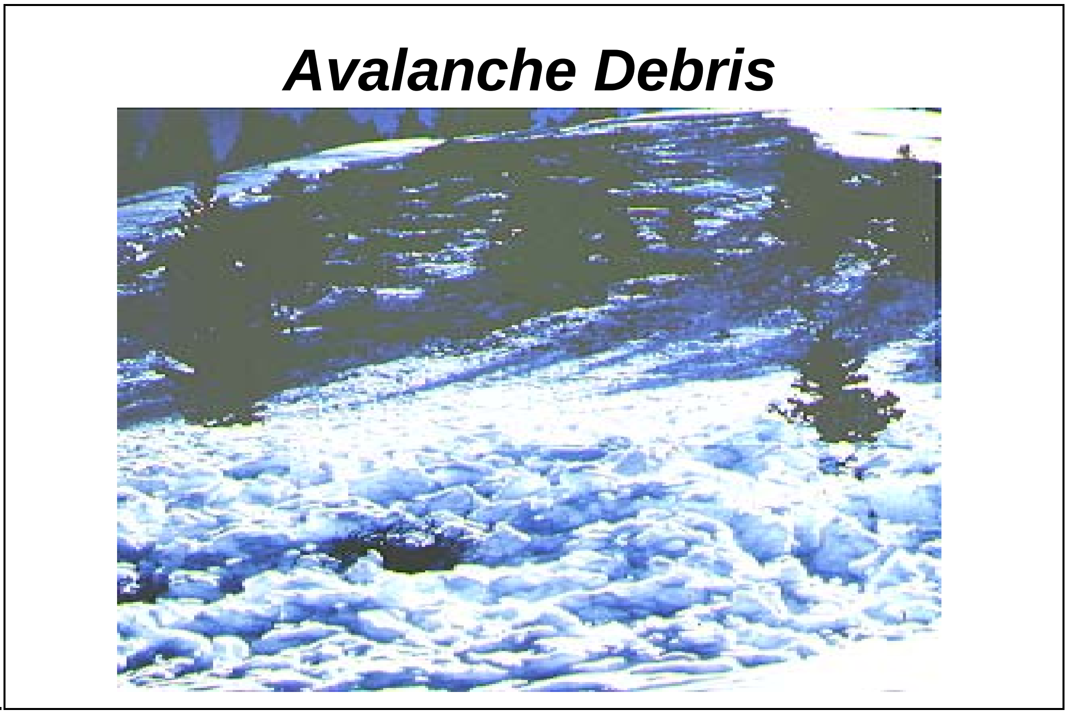
a. (Slide 7) One of the most obvious results of an avalanche is the burial of people. As this chart shows, as burial depth increases, the probability of survival decreases. Being buried is not necessarily the cause of death. Trauma from impact with objects and asphyxiation are the leading causes of fatalities. Asphyxiation happens as a result of the victims warm exhalations melting a fine layer of snow around the nose and mouth. This creates an ice mask which prohibits fresh air from reaching the victim.



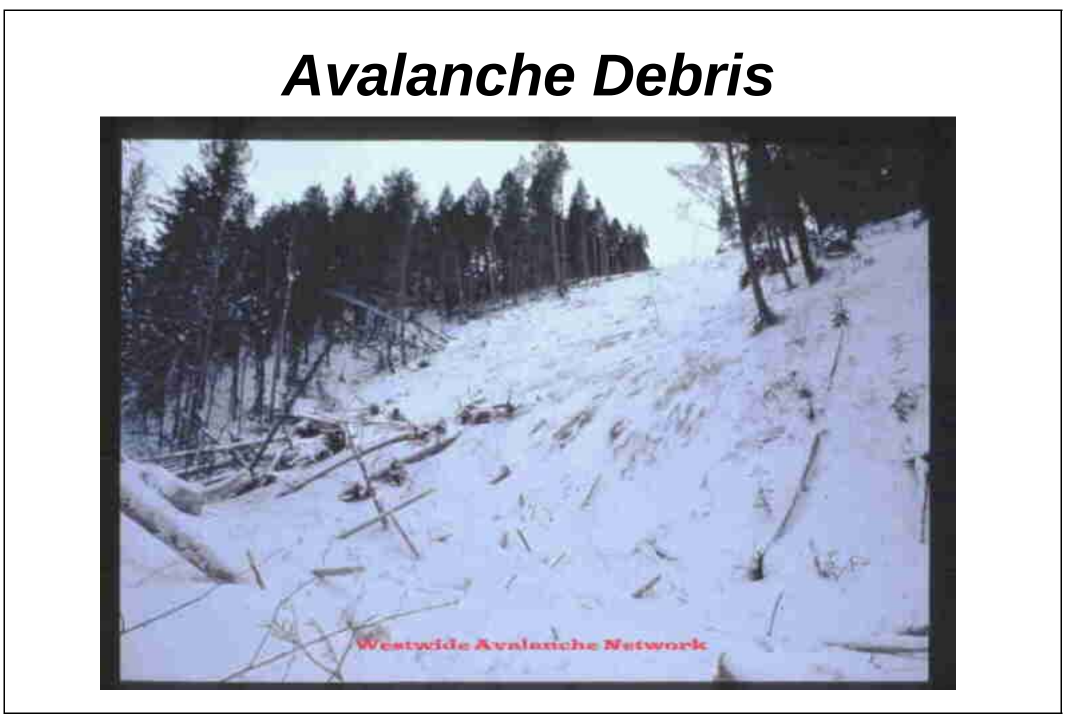
b. (Slide 8) The probability of surviving a burial diminishes with each passing moment. The chance of survival drops to half after 15 minutes. As you can see from this chart, companion rescue is most effective. If you witness an avalanche that buries people, you are the best chance of getting those persons out alive. If you go for the help of an organized rescue, you are going for a body recovery.



c. (Slide 9) Many tons of debris moved down this slope. As a slide moves downhill, it may reach speeds approaching 200 miles an hour given the right conditions. In addition to the snow blocks, the surrounding terrain features also become hazards. The victim may impact trees and rocks as well as debris being carried within the snow. When the snow comes to a halt it sets up very hard, almost like concrete. This is caused by the massive amounts of snow rubbing each other casing friction and heat. This friction causes the snow to become a semi liquid. After stopping the cold temperature of the air and snow causes it to refreeze immediately.

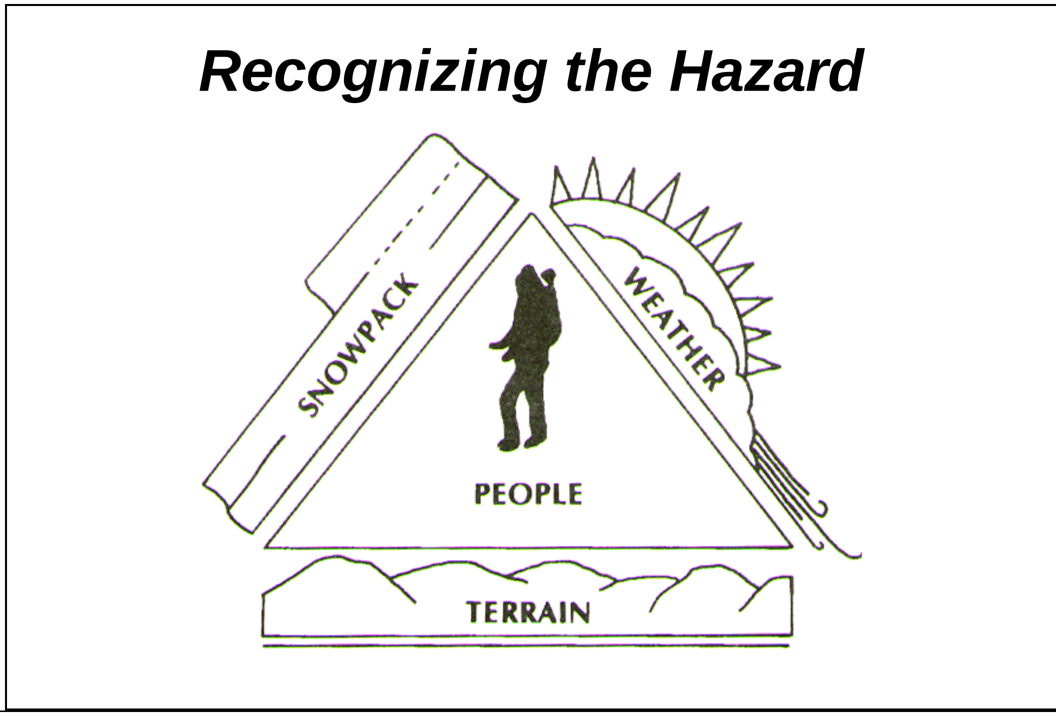


d. (Slide 10) Even though this slope had adequate anchors, the snow-pack above the tree-line slid and the weight and force of the moving snow removed all vegetation from the slope.



ELO B	**ACTION**	Describe the four elements (terrain, weather, snow pack and people), that contribute to the creation of an avalanche
	CONDITION	In a classroom environment
	STANDARD	Describe the four elements (terrain, weather, snow pack and people), that contribute to the creation of an avalanche IAW the NWTC Cold Weather Operations Manual.

a. (Slide 11) There are four elements to consider – Terrain, Snow pack, Weather and People. Without people there is no hazard.



Learning Step/Activity 1 – Terrain

a. (Slide 12) The first thing we will consider is the terrain itself. Is it capable of producing a slide? What angle slopes will slide? How do I determine what this slope angle is? What other terrain characteristics contribute to slope instability?

b. Typically, as the slope angle increases, the probability of an avalanche increases. Based on statistics, without an angle greater than 20°, the gravitational force on the snow pack is typically not great enough to produce a slide. While avalanches usually occur on slope angles between 20° and 60°, a majority of avalanches occur between 30° and 45° and a disproportionately large number occur between 35° and 40°. The "sweet spot" seems to be 38 degrees. Although slope angles above 55° predominately produce loose snow slides, slab avalanches can occur. Snow falling on the steeper slopes tends to "sluff" off upon falling.

c. The failure of the elastic energy in a slab of snow is the basis of an avalanche. Elastic strength is defined as the strength within a slab cross section. An example of elastic strength is the strength necessary to tear a pan cake apart with two hands. With enough force, the slab will separate from itself, with one side remaining on the slope while the other slides downward. In the example with the pancake, the outside force was the strength of the hands. In the snow pack, the outside force could be a skier, snowshoer, other travelers, cornice breaks, or other natural occurrences putting stress on the snow pack. In simple terms, the proverbial "straw that broke the camels back" is all that's needed to start an avalanche. An outside force is anything that comes in contact with the snow pack and not just on the upper slopes either. An avalanche could be triggered from the valley floor away from the slope. The slab structure will sometimes encompass all of a valley floor and a surrounding slope.

Terrain

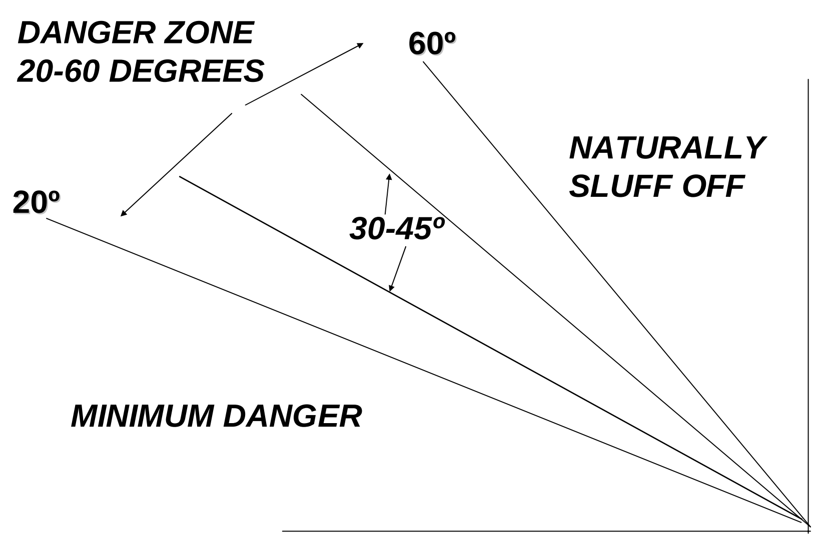
- ***Can it slide? Is it capable of producing avalanches?***
- ***How do I measure the Slope Angle?***
- ***Terrain characteristics***

d. (Slide 13) Graphic representation of slope angles and potential danger. In general terms, avalanches occur on slopes of 20-60 degrees. On slopes steeper than 60 degrees snow sloughs off naturally. On slopes less than 20 degrees gravity can't work on the snow pack so few or no slides occur, although given the right conditions an avalanche can occur, but usually won't be destructive.

e. A majority of avalanches occur between 30-45 degrees, with the majority at 35-40 degrees. The most common point of release is 38 degrees.

f. The reason we measure slope angle is to determine if the snow can move. A lot of terrain can be eliminated as a hazard area just by measuring the angle. Bear in mind that just because the angle is prime to move does not make it so. There are other things to consider.

Can it slide?



g. (Slide 14) There are several methods used to measure slope angle. Some compasses have an inclinometer built in, there are several stand alone inclinometers manufactured. These devices all cost money and this prohibits their mass issue. The issued Army Protractor, GTA 5-2-12, 1981, can be modified to read slope angle easily.

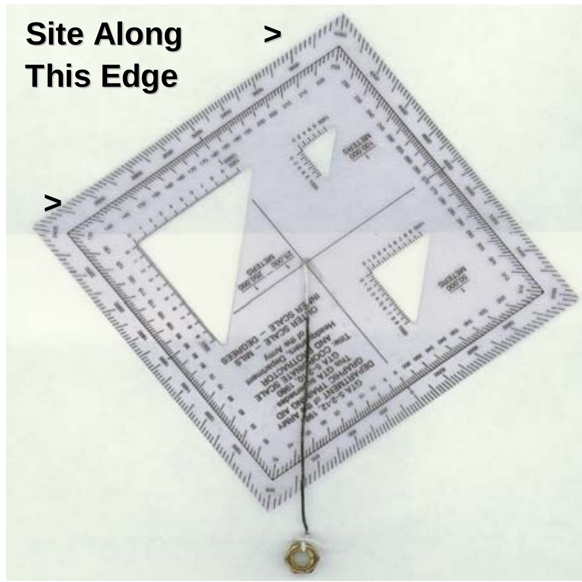
(1) Hold the card so the text can be read.

(2) Punch a hole in the exact center of the device and thread a tiny string through and tie a securing knot on the backside of the card.

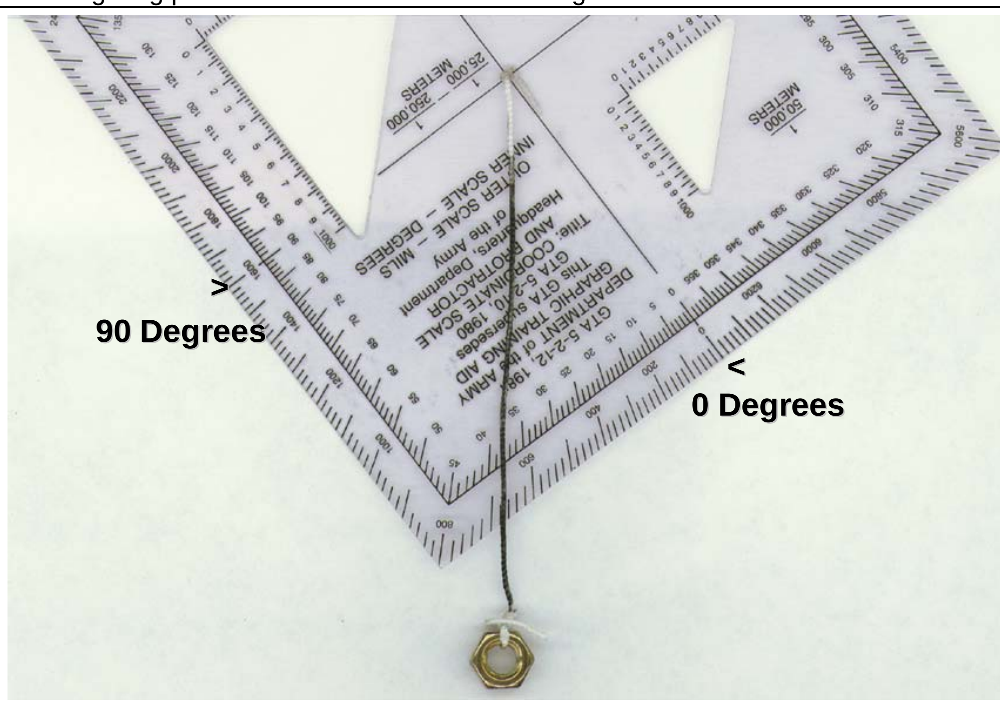
(3) Extend the string far beyond the farthest corner of the card; add 2 - 3 inches and cut the string.

(4) Tie a weight, such as a small washer or nut, to the fresh cut end.

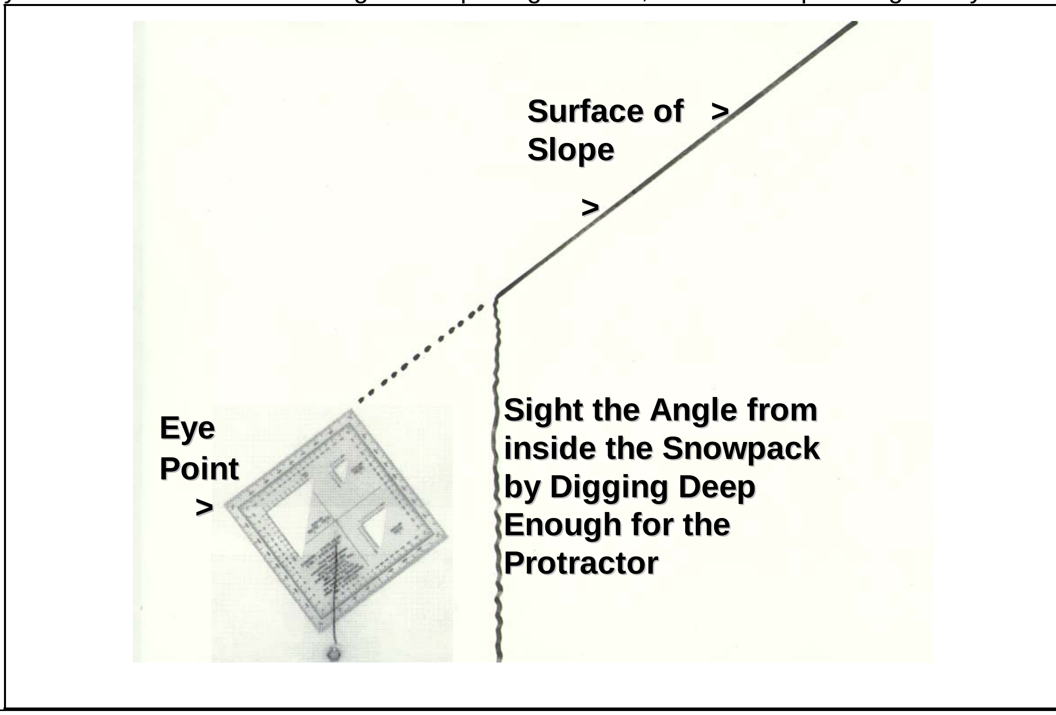
How do I measure the slope angle?



h. (Slide 15) Hold the card vertically so the data is legible and rotate until the weighted string hangs on the zero mark. The corners containing the 2400 and 4000 mil marks define the sighting edge of the device, with the eye point being the 2400 mil corner. Hold the card vertically, aligning the sighting edge with a slope and allowing the string to hang freely against the card. When the string is stable, pinch it on the outside edge of and against the card between the thumb and a finger. Move the card from the sighting position and read the indicated angle.

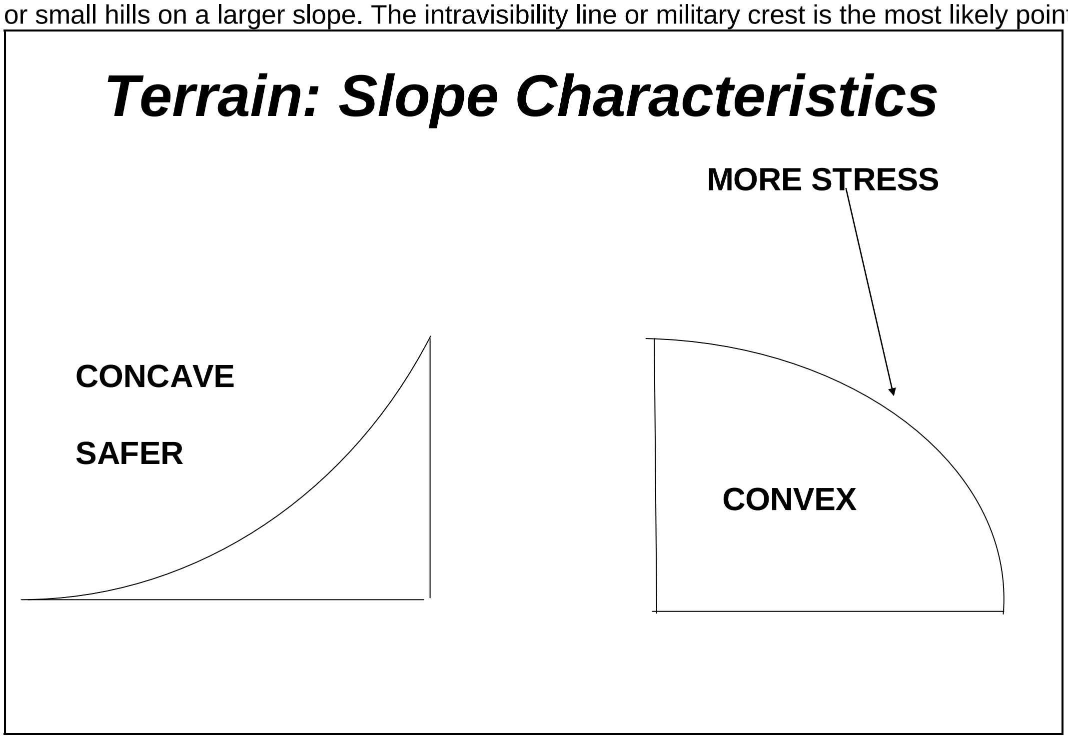


i. (Slide 16) Dig into the snowpack deep enough to align the site edge with the slope. Orient the card to the slope as in the photo and ensure the card faces are vertical as in the photo. As the string is hanging steady, pinch the string and the outer edge of the card between the thumb and a finger. Turn card so you can read the indicated angle. If slope angle varies, use the steepest angle for your assessment.



j. (Slide 17) In broad general terms, a concave slope is safer than a convex slope. The reason is that a concave slope is under compression, meaning it is being pushed together. However as you go higher the angle increases thus increasing the danger.

k. The convex slope is under tension, meaning it is being pulled apart. This is quite evident on “rollers” or small hills on a larger slope. The intravisibility line or military crest is the most likely point of fracture.



l. (Slide 18) Anchors will hold snow under most conditions. Grass and smooth rock will not hold snow for very long. Talus, and downed trees slopes will hold the very bottom layers until the snow depth covers the top of the rocks or trees. Standing trees will hold surrounding snow, but a slide can still occur especially if the trees are widely spaced.

Terrain: Anchors

- ***Grassy slopes or smooth rock make for an unstable slope***
- ***Jumbled rock, deadfall will anchor bottom layers***
- ***Trees will anchor surrounding snow, but***
- ***beware of snow above tree line coming down***

m. (Slide 19) Terrain traps are areas of no escape because snow will naturally move to them. Gullies, couloirs, creek beds and canyons are places that people will go because the traveling is easier but an avalanche from above can fill these areas. A cliff below a line of travel also presents the problem of going over the edge if swept away.

Terrain Traps

Gullies,couloirs,creek beds,canyons

n. (Slide 20) The avalanche above this canyon filled in the low ground. Be aware of the hazard above.

Terrain Traps

a. (Slide 21) There are three elements required which when under the right conditions can produce an avalanche. These are:

(1) Slab: One or more layers of generally cohesive strongly bonded snow.

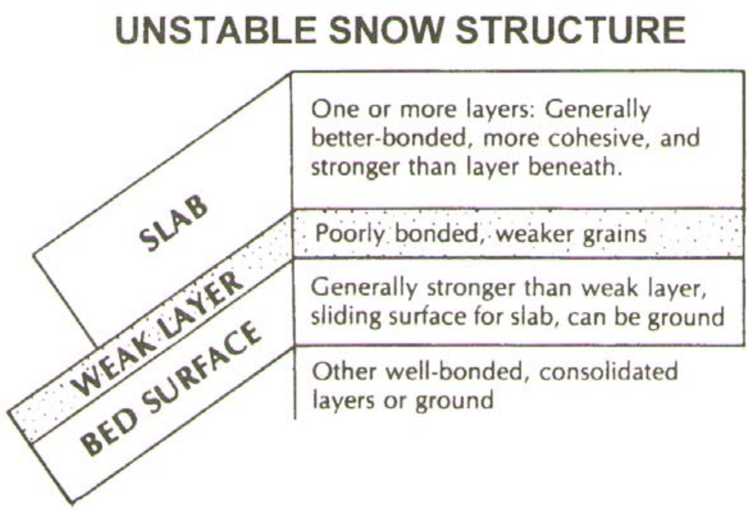
(2) Weak Layer: This is a layer of poorly bonded snow. It will often be loose and granular and it is often called sugar snow, because it has the same consistency of loose, dry sugar.

(3) Bed Surface: This is another layer of consolidated snow, ice or the surface of the ground.

b. The failure of the elastic energy in a slab of snow is the basis of an avalanche. Elastic strength is defined as the strength within a slab cross section.   What needs to be remembered is that the underlying weak layer is not holding (or doing a poor job of holding) the slab in place. The elastic energy is the main holding force on the slab. With enough outside force, the slab will separate from itself, with one side remaining on the slope while the other slides downward (on the weak layer which now acts like ball bearings). In the snowpack, the outside force could be a skier, snowshoer, other travelers, cornice breaks, or other natural occurrences putting stress on the slab. Therefore when the strength of a cross section of the slab is weakened (by an outside force), the slab will break away from itself.

c. There are many layering combinations; the three layers mentioned are only one possibility. These various combinations are dependent upon a number of weather factors which create layers within the snow pack.

Snowpack: Ingredients for an Avalanche



Learning Step/Activity 3 - Weather
a. (Slide 22) These things are contributing factors to the stability of a snow pack. They can be very broad effecting large areas or extremely localized.

Weather

- ***Wind Action***
- ***Precipitation***
- ***Slope Aspect***
- ***Temperature***

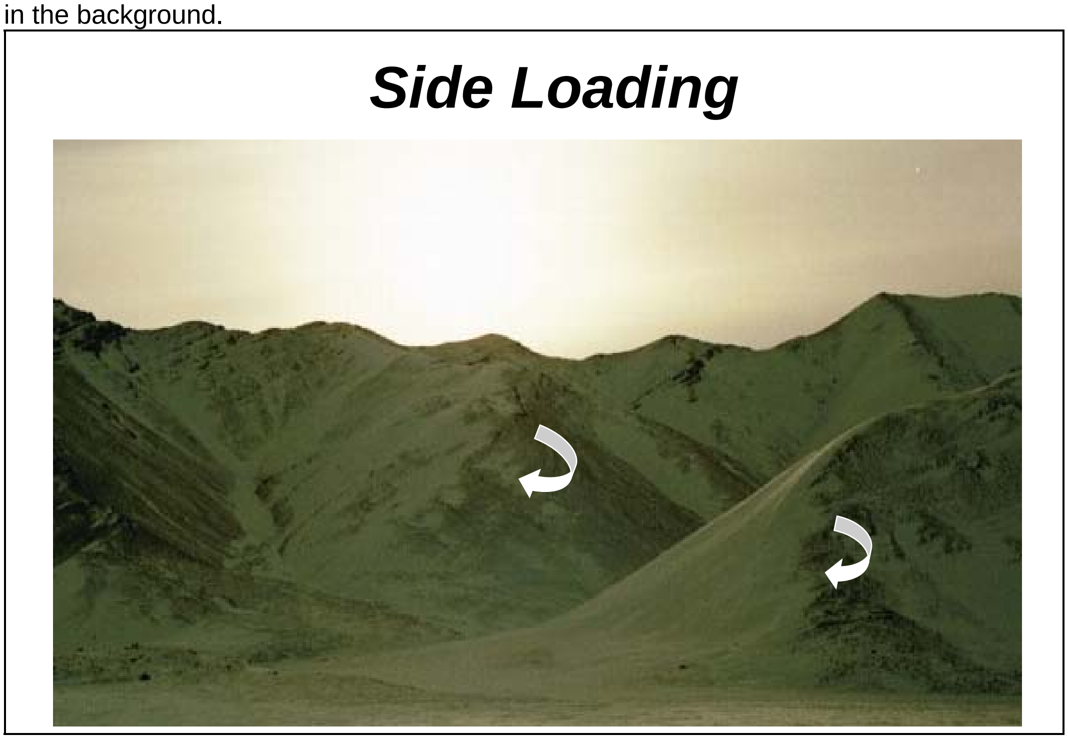
b. (Slide 23) Wind will transport snow from one area to another. This action can more than double the snow on the lee side of a given slope. When this snow is deposited it forms a hard slab of compacted snow. Because there is so much more snow, the weight alone can trigger a very destructive slab avalanche. Snow can be top loaded, meaning it comes over the top of a feature, or side loaded meaning it comes around. Either way the result is the same. If travel is necessary, stay on the windward side.

Wind Loading

Wind moves snow from one area to another forming a wind slab

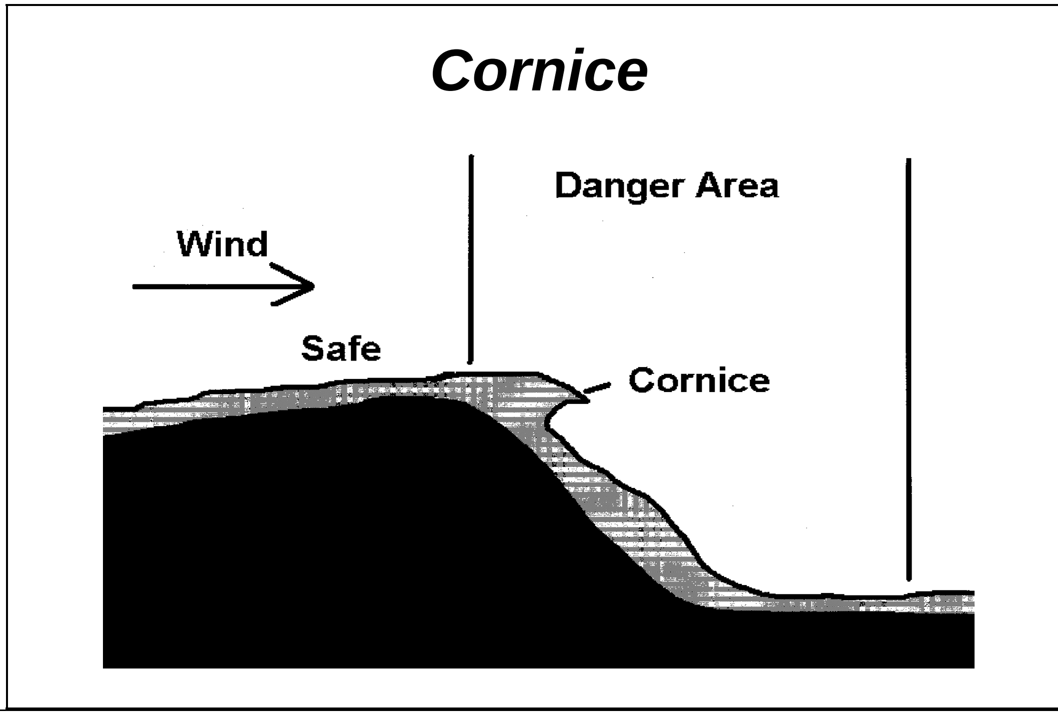
b. (Slide 24) The bare area is the windward side. The lee side was top loaded.

c. (Slide 25) Evidence of side loading. This picture also shows how much snow collects in the couloirs in the background.

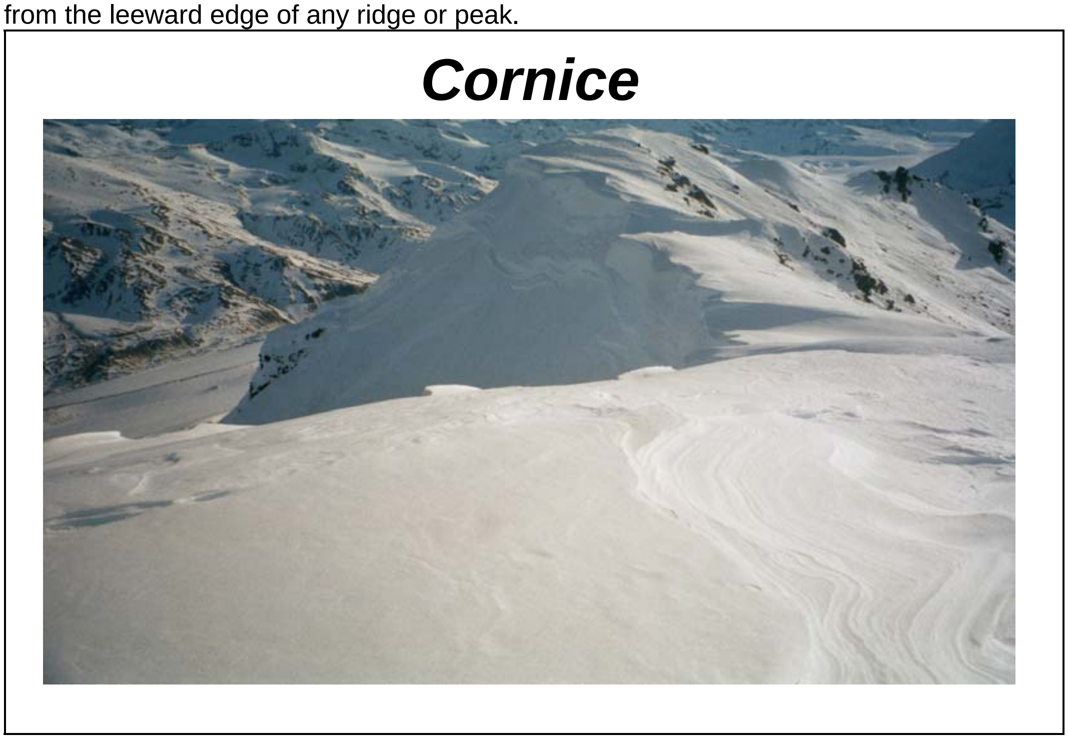


d. (Slide 26) Cross section view of a cornice. A cornice is formed by the wind blowing snow that builds a “bridge” that gets bigger with time. These may reach out away from the slope 20-30 feet. In some areas with turbulent winds they may be doubled on both sides of the ridge. On glaciated peaks there may be a crevasse present along the long axis of the ridge. The safe area of travel is well down hill on the windward side.

e. A cornice can break off and start an avalanche.



f. (Slide 27) The whole top of this peak is corniced, extending approximately 15 feet from the ridge. A person would not know they are standing over the void until they were right on top of it. Stay well back from the leeward edge of any ridge or peak.



g. (Slide 28) A closer view of the cornice extending 15 feet from the ridge.

Cornice

h. (Slide 29) Recent heavy snow or rain is a contributing factor to avalanche danger. Both forms of precipitation add weight to the snowpack stressing the elastic strength.

i. Snow falling at a rate of one inch or more per hour is cause for immediate concern. Most natural releases will occur within 24 to 48 hours following a storm.

Precipitation

- ***Snow Fall***
- ***Slush (Rain Caused)***

j. (Slide 30) The aspect of a slope, or the direction it faces, greatly affects the occurrence of avalanches. North-facing slopes are usually more prone to avalanche in mid-winter while south-facing slopes are more dangerous in spring and on sunny days. As the sun moves to shine on a particular slope during the day, that slope usually becomes more avalanche prone.

Slope Aspect

- ***North facing slopes are avalanche prone in mid-winter***
- ***South facing slopes are more dangerous in spring and on sunny days***

k. In a perfect world snow forms a six sided crystal called a stellar crystal. This is the same shape as what would be seen on a Christmas card. As these crystals fall through the atmosphere, the sharp edges lock onto each other. Upon reaching the ground, they continue to lock into each other forming a layer. Snow that forms as other crystals such as dendrites, plates and columns will bond differently or not at all. Graupel is similar to little beads that will generally not bond together at all.

l. As time passes the crystalline structure deteriorates and the snow will look like barbells joined together. This is the perfect snow pack.

m. Changes in temperature affect the bonding process of the crystal structure of the snowpack. This bonding is the cause of slab formation. Extreme drops in temperature will make the snowpack more brittle and likely to fracture. As temperatures in the snowpack increase, the bonding time of recent snow to old snow is decreased. In other words, a warmer temperature increases the stability of the snowpack. However, when temperatures rise above freezing, rain and meltwater can rapidly destabilize an otherwise safe snowpack. Increases in temperature can cause wet snow slides. If a cold snap occurs after a warm spell, the snowpack can freeze solid and bond very well. But this may form a layer of ice, resulting in a smooth surface layer.

n. As temperatures increase, the bonding of the crystals happens more rapidly. This process is called the freeze/thaw cycle. Temperature usually drops after a storm. Snow covered terrain is usually most unsafe immediately after a storm due to the lower temperatures delaying the freeze/thaw process.

Temperature

- ***Wet slab avalanches from excess warmth or rain***
- ***Determines bonding of the snow through the freeze thaw cycle***

Learning Step/Activity 4 - People

a. (Slide 32) If the terrain, weather and snow pack conditions add up to unsafe conditions, adding people will often result in an avalanche. There are many factors that contribute to this. Recreationally, people often have limited time to play and will often ignore blatant avalanche warning signs. Ignorance of the hazard can also contribute to accidents. Slabs as shallow as a few inches thick have slid and killed people. For the military, focus on the mission can cause leaders to ignore the warning signs. This was evident on a large scale in World War I on the Austro-Italian front where over 60,000 soldiers focused on the mission lost their lives to avalanches (most of them triggered by themselves). Overconfidence can also play a role. If you have traveled to an area repeatedly with no consequences you may be conditioned to expect that the area is always safe. You may also feel that you and your travel partners have the necessary training and equipment so that even if there is an avalanche, you can help yourselves. Look at the whole picture of what is happening and make an informed decision about whether or not to travel.

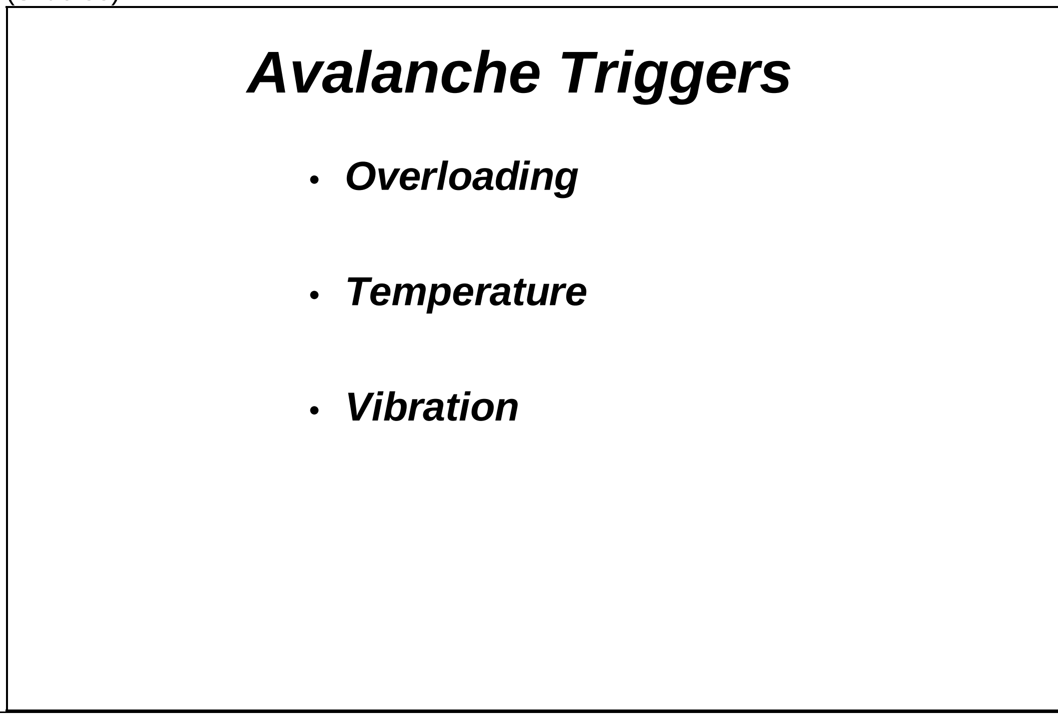
People: Human Factors

- ***Mission focused***
- ***Traveled through an area many times and it was always safe before***
- ***Brain not engaged***
- ***Drinking***
- ***Don’t know don’t go; you control this***

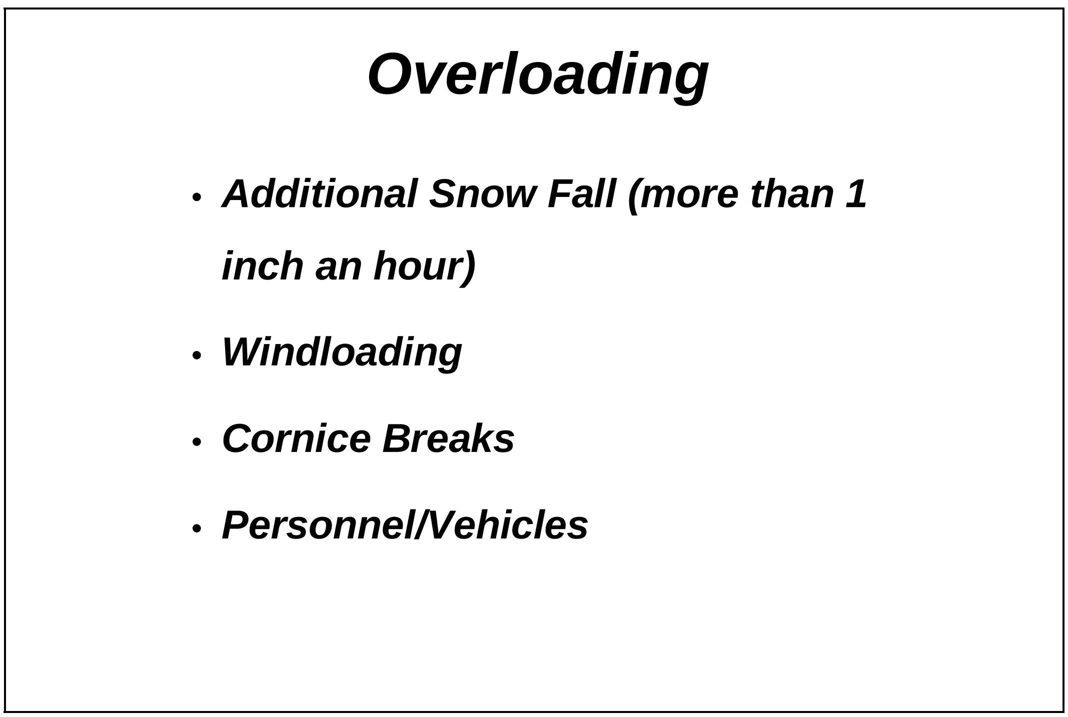
ELO C

ACTION	Describe common avalanche triggers
CONDITION	In a classroom environment
STANDARD	Describe common avalanche triggers IAW the NWTC Cold Weather Operations Manual.

(Slide 33)



b. (Slide 34) When more than one inch of snow falls per hour there is a rapid load being placed on the existing snow. This is also the case during a wind event. A cornice break can impact the snow with significant force and people moving on snow can also cause it to move.



c. (Slide 35) A vibration can set off an avalanche. The scene in a movie where a single gunshot or someone yelling is totally un-realistic.

Vibration

- *Explosions*
- *Earthquakes*
- *Vehicles*
- *Aircraft*

d. (Slide 36) Demolitions can be used to set off unstable snow. The use of decommissioned artillery pieces and air cannons at ski resorts and roads is a wide spread practice. It must be noted though, the charge must hit the "sweet spot", and some instability must be present in order to be effective. Use of artillery to clear a slope (Selkirk Range, Canadian Army) is pictured. During WWI and WWII, forces waited for units to move under likely avalanche paths and used artillery to create slides (though this was not common).

Demolitions

- *Trigger avalanche(s) prior to moving*
- *Must be detonated in the correct position*
- *Could give away position*

ELO D

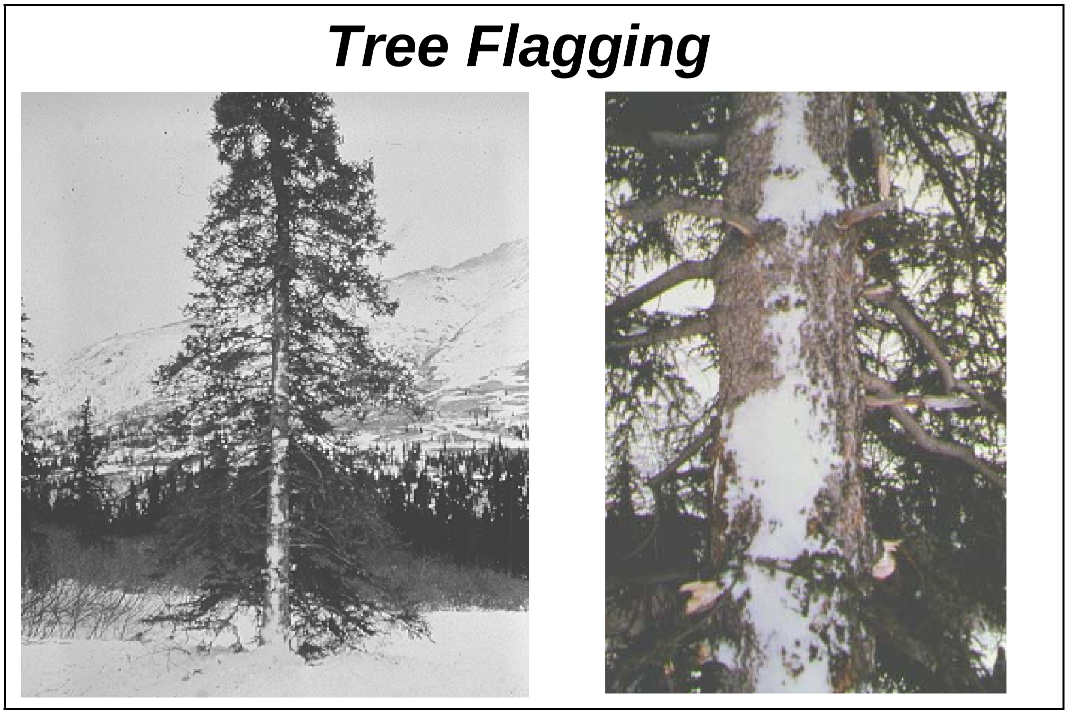
ACTION	Describe general indicators of avalanche prone terrain
CONDITION	In a classroom environment
STANDARD	Describe general indicators of avalanche prone terrain IAW the NWTC Cold Weather Operations Manual.

a. (Slide 37) Evidence of previous avalanches- debris piles at the base of a slope, flagged trees, trees all pointed away from the slope
b. Steep slopes between 30º and 45º
c. Heavy snowfall- added weight to the existing snowpack
d. Visible fracture lines in the snow- even on low angle terrain indicates possible weaknesses on surrounding steeper terrain
e. Audible settling of the snowpack- a “whumpf” sound comes from collapse of an underlying weaker layer of snow or hoar frost
f. Severe changes in temperature- increasing temperature increases weight of surface layer(s) through melting
g. Lee slopes- usually are topped by a cornice; as the cornice is built the excess snow is deposited downslope by the same wind and adds weight to the existing snowpack
h. Snow plumes and high winds- build cornices and leeward deposits
i. Slushy "spring" snow- very heavy and apt to slide at high angles
j. An outside force to give the force to break the stability

General Indicators of Avalanche Prone Terrain

- ***Evidence of previous slides***
- ***Steep slopes between 30-45 degrees***
- ***Recent heavy snowfall adding to the weight of snowpack***
- ***Visible fracture lines in the snow***
- ***Audible settling of the snowpack***
- ***Severe temperature changes***
- ***Lee slopes***
- ***Snow plumes and high winds***
- ***Slushy spring snow***
- ***Outside force to break the stability***

h. (Slide 38) Flagging- vegetation shows signs of destruction from up slope; clear swaths surrounded by vegetation are previous avalanche paths; trees bent, broken trees, trees with branches missing up to a certain height are indicators that an area is prone to slides. Closer inspection reveals the size of the limbs and the force of the avalanche.



ELO E		
	ACTION	Describe route selection and hazard evaluation procedures in avalanche prone terrain
	CONDITION	In a classroom environment
	STANDARD	Describe route selection and hazard evaluation procedures in avalanche prone terrain IAW the NWTC Cold Weather Operations Manual.

Learning Step/Activity 1 – Route Selection

a. (Slide 39) The most important part of military mountaineering is the ability to evaluate mountain hazards and select a way to avoid them or mitigate the risk if it is impossible to avoid the hazard. While traveling in snow covered, and potentially avalanche prone terrain there are a number of considerations for proper route selection. The answer to the question on the slide is almost always YES! Some of the considerations have already been discussed such as traveling on windward slopes as opposed to leeward slopes and avoiding terrain traps suck as creek beds and travel below cliffs.

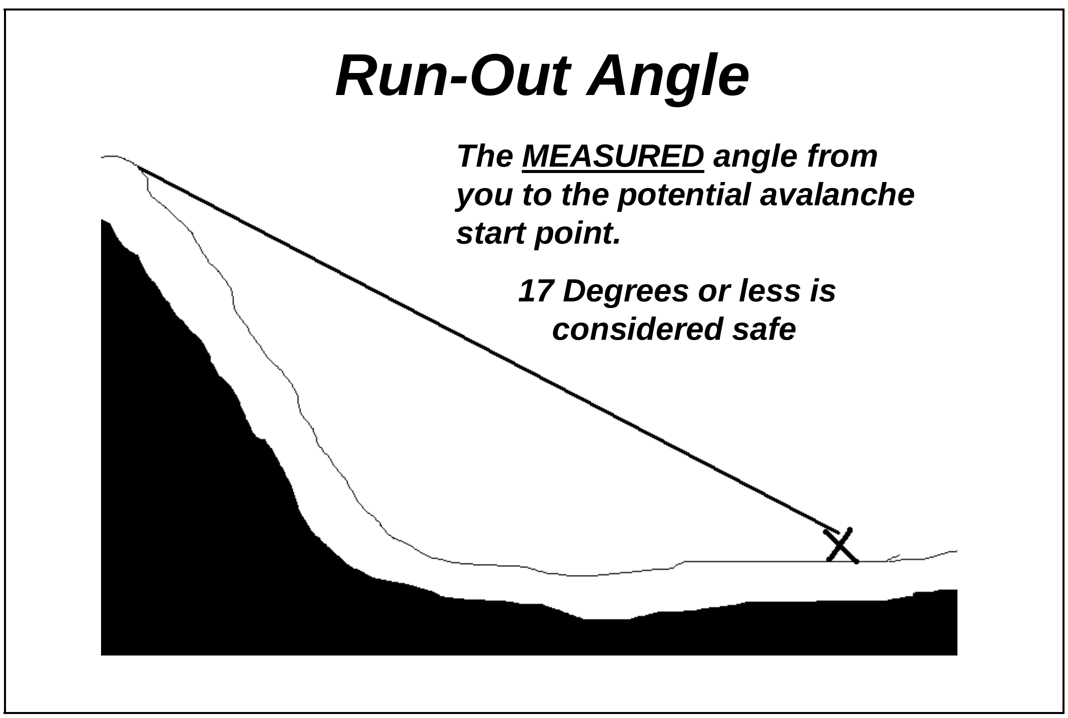
Route Selection: ***<u>Is there a SAFER route?</u>***

b. (Slide 40) Travel in Valleys. Sometimes travel below snow covered slopes is unavoidable. A consideration of the past weather and current snow pack conditions combined with common sense route selection (as far away from the potential slide path as possible) can make for safe travel. Consider the run-out area of any potential slides.

Route Selection: Travel in Valleys

- ***Traffic in the valley floor can trigger slides from above.***
- ***How will you know the risks?***
- ***Consider your Run-out Angle for safe travel in valleys***

c. (Slide 41) Run-out (Alpha) Angle-The measured angle from your location to the potential avalanche start point. This is based on elevation difference and potential runout distance. 17º or less is considered safe. Once a safe alpha angle has been achieved, insure you did not back into another hazardous area. Consider all surrounding slopes. The higher the start point upslope, the further you need to be from the base of the slope for safety. Watch your back for opposing Alpha Angle problems.



Learning Step/Activity 2 – Hazard Evaluation

a. (Slide 42) Snow Pack Stability Tests - There are many tests that you can perform on the snowpack to determine stability. Many of the tests will tell you nothing unless you study snowpack science and study snowpack frequently enough to remain proficient and use the knowledge. For the average snow terrain traveler, there are a few tests that produce practical results and are simple to perform. These tests will be demonstrated in the field during the course of instruction.

Hazard Evaluation: Snow Pack Analysis

- ***Ski-pole***
- ***Snow-pit***
- ***Shovel Shear***
- ***Rutschblock Test***
- ***Banzai Test***

b. (Slide 43) This is a hazard evaluation checklist designed by the Alaska Mountain Safety Center. It lists all the four elements required for an avalanche and asks questions designed to determine the hazard level associated with the current conditions and circumstances. It uses a Green (Safest), Yellow (Caution Advised) and Red (No Go) system to make the evaluation. The five step risk management process is another way to evaluate the hazard.

Avalanche Hazard Evaluation Checklist

AVALANCHE HAZARD EVALUATION CHECKLIST

Critical Data PARAMETERS:	KEY INFORMATION	Hazard Rating G	Y	R
TERRAIN:	*Is the terrain capable of producing an avalanche?*			
	-Slope angle (steep enough to slide? prime time?)	☐	☐	☐
	-Slope aspect (leeward, shadowed, or extremely sunny?)	☐	☐	☐
	-Slope configuration (anchoring? shape?)	☐	☐	☐
	Overall Terrain Rating:	☐	☐	☐
SNOWPACK:	*Could the snow fail?*			
	-Slab Configuration (slab? depth and distribution?)	☐	☐	☐
	-Bonding Ability (weak layer? tender spots?)	☐	☐	☐
	-Sensitivity (how much force to fail? shear tests? clues?)	☐	☐	☐
	Overall Snowpack Rating:	☐	☐	☐
Weather:	*Is the weather contributing to instability?*			
	-Precipitation (type, amount, intensity? added weight?)	☐	☐	☐
	-Wind (snow transport? amount and rate of deposition?)	☐	☐	☐
	-Temperature (storm trends? effects on snowpack?)	☐	☐	☐
	Overall Weather Rating:	☐	☐	☐
Human:	*What are your alternatives and their possible consequences?*			
	-Attitude (toward life? risk? goals? assumptions?)	☐	☐	☐
	-Technical Skill Level (traveling? evaluating aval. hazard?)	☐	☐	☐
	-Strength/Equipment (strength? prepared for the worst?)	☐	☐	☐
	Overall Human Rating:	☐	☐	☐

Decision/Action:
Overall Hazard Rating/GO or NO Go? **GO ☐ or NOGO ☐**

***HAZARD LEVEL SYMBOLS:**
R = Red light (stop/dangerous)
G = Green light (go/OK)
Y = Yellow light (caution/potentially dangerous).

ELO F

ACTION	List additional procedures for travel in avalanche prone terrain and describe procedures before, during and after an avalanche occurs
CONDITION	In a classroom environment
STANDARD	List additional procedures for travel in avalanche prone terrain and describe procedures before, during and after an avalanche occurs IAW the NWTC Cold Weather Operations Manual.

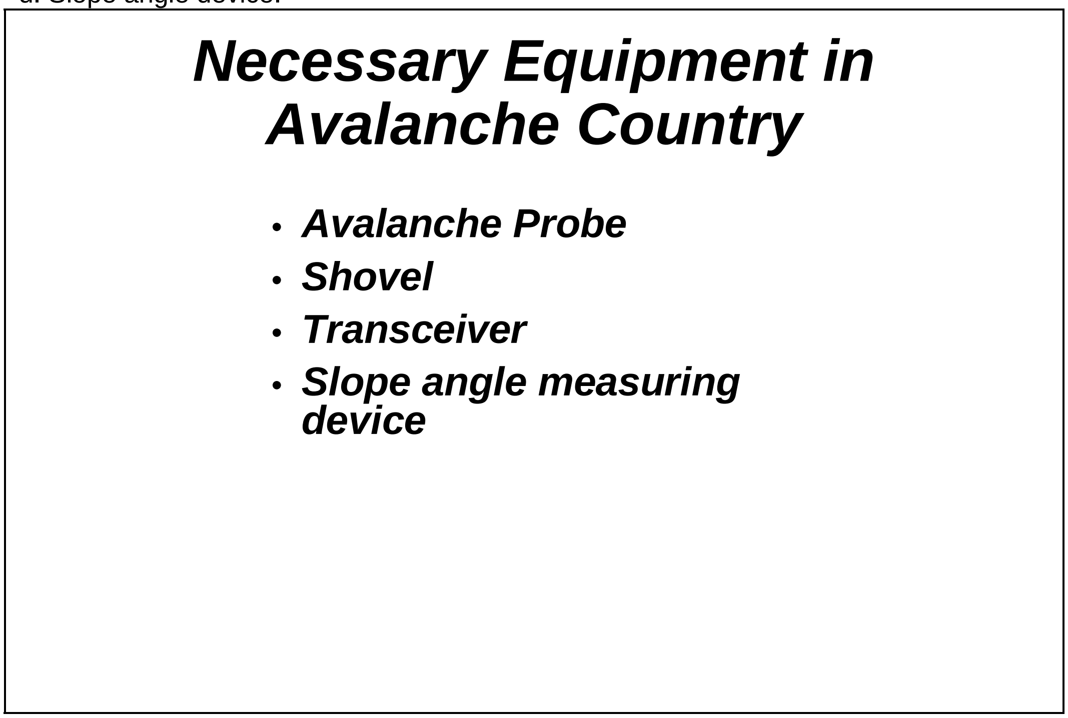
Learning Step/Activity 1 – Necessary Equipment in Avalanche Country’

a. (Slide 44) Avalanche Probe- at least eight feet long, ten is better; typical construction is many shorter sections connected by a cable, similar to tent poles

b. Shovel- heavy duty, wide blade, short handle, packable. Plastic shovels are dubious.

c. Transceiver- quickest device used to locate a victim; they are quite expensive, about $200.00 each. THEY WILL NOT KEEP YOU FROM GETTING IN TROUBLE AND SHOULD NOT BE A REASON TO TAKE CHANCES! Must have at least two- one transmitting from the victim and the other switched to receive and worn by the searcher. A significant amount of time must be dedicated to gain proficiency.

d. Slope angle device.



Learning Step/Activity 2 - Crossing a Questionable Slope

a. (Slide 45) If a questionable slope must be crossed the following actions must take place:

(1) Route must be the shortest possible. If possible use “islands of safety” such as trees, exposed rocks etc.

(2) A watch is posted to note the person’s direction of travel and note where they went if a slide should happen.

(3) Disconnect ski pole and ski binding leashes so they can be discarded rapidly. A heavy rucksack can drag you under, a light puffy rucksack can aid in flotation.

(4) Cross one at a time.

Crossing a Questionable Slope

- ***Loosen equipment***
  - ***Remove pole straps from wrists Disconnect safety leashes from skis***
  - ***Loosen rucksack straps***
- ***Cross one at a time with a watch posted***

Learning Step/Activity 3 - Crossing a Questionable Slope

a. (Slide 46) Discard ski poles and skis if able. Also discard a heavy pack.
b. A swimming motion can help to maintain a surface position. Fight hard to maintain this surface position.
c. Try to form an air space as soon as you stop.

If Caught in an Avalanche

- ***Attempt to release skis***
- ***Remove heavy rucksack***
- ***Use Swimming Motion***
- ***Create an Air Space***
- ***Try to find the surface***

Learning Step/Activity 4 – If you are a witness to an avalanche

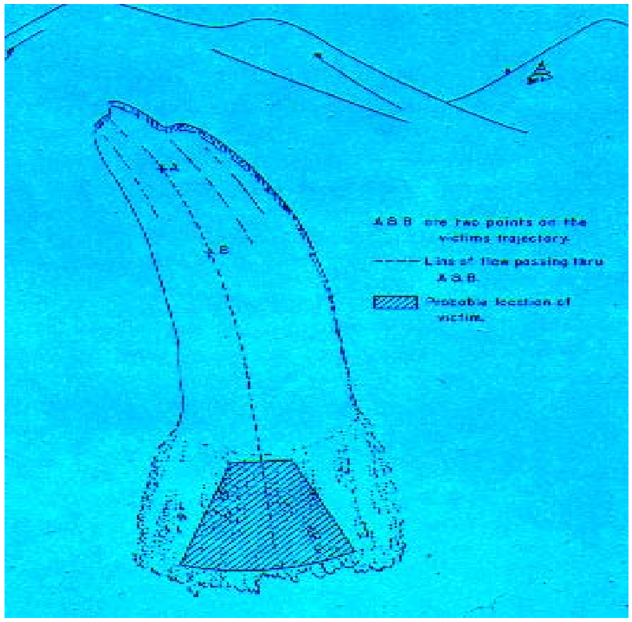
a. (Slide 47) Watch the victim. Note where they went on the slide path and terrain traps that may hold them.
b. After the area has been ascertained to be safe, begin looking for the victim.
c. Go to the last point seen and mark it.
d. Look downslope for surface clues, but do not remove them. Use them as you would the sights on a rifle. They will usually point downhill to the area of burial.
e. Begin a beacon search if your group has them. Ensure EVERYBODY is in receive mode. Some of the party can begin in the deposition zone, others in terrain traps. There is one person in charge and the effort must be organized. Utilization of beacons will be covered in a practical exercise in the next block of instruction.
f. If the party was not using beacons then probing will be necessary. Avalanche probes are preferred, but ski poles with the baskets removed, long sticks, or any other long rigid object will work.
g. Don' t go for help. You are the help.

If you witness others caught in an avalanche

- ***Keep your eyes on the victims.***
- ***Note terrain traps***
- ***Look for surface clues***
- ***Organize search***
- ***Don't go for help. YOU ARE THE HELP!***

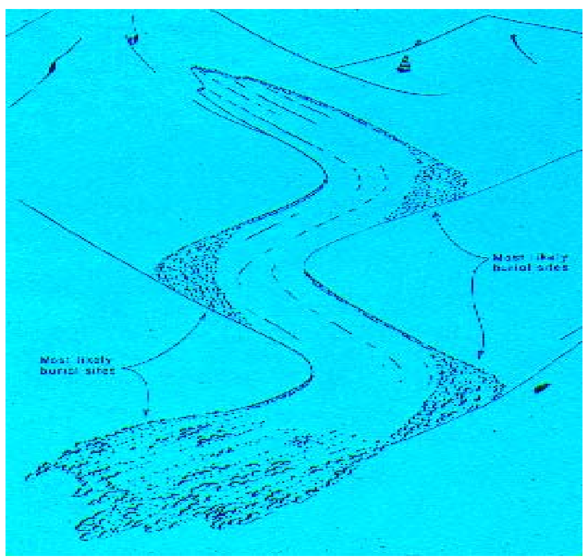
b. (Slide 48) Points A and B are the last seen points or surface clues. The victim should be directly below.

Last Seen Points



c. (Slide 49) The outside curves are likely burial places. In front (upslope side) of rocks, trees etc. are likely places also.

Debris Deposits from a Slab Avalanche



SECTION IV **SUMMARY**

Check on Learning

1. What are the four elements required for an avalanche?
Terrain between 20 and 60 degrees slope angle, an unstable **snow pack** that contains a slab, weak layer and bed surface, the **weather** conditions to create the unstable snow pack and a **trigger** such as a skier.

2. Does having a slab on a slope of 30 degrees mean that the slope will slide?
Not necessarily. If there is a weak layer and bed surface below the slab and there is a trigger there is a high probability of a slide. But the presence of a slab itself on a 30 degree slope does not mean that the snow will avalanche.

Review and Summarize Lesson

The Terminal Learning Objective for this lesson was:

ACTION:	Identify and evaluate the risk of an avalanche take steps to mitigate this risk
CONDITION:	In a classroom environment
STANDARD:	Identify and evaluate the risk of an avalanche take steps to mitigate this risk IAW the NWTC Cold Weather Operations Manual.

Transition to next lesson

As per NWTC training schedule; dependent upon course in conduct.

SECTION V	STUDENT EVALUATION
Testing Requirements	Students will be tested on their knowledge of avalanche hazards during a one hour written exam at the conclusion of the course (Refer to training schedule for date/time of exam). Students will conduct a practical exercise using the knowledge from this lesson and the knowledge gained from field training C016 Avalanche Practical Exercise).
Feedback Requirement	Instructors will reinforce this lesson during field portions of training through discussions of route selection and hazard evaluation while conducting movements during the course.